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(54) Ceramic honeycomb body

(57) A ceramic honeycomb body has channels near the outer peripheral wall (1) thereof which are filled with a ceramic or other reinforcing material (2) over the entire length of the channels or over a certain depth from both end surfaces of the channels, and can be advantageously used as a catalyst support for purifying exhaust gases of an internal combustion engine.

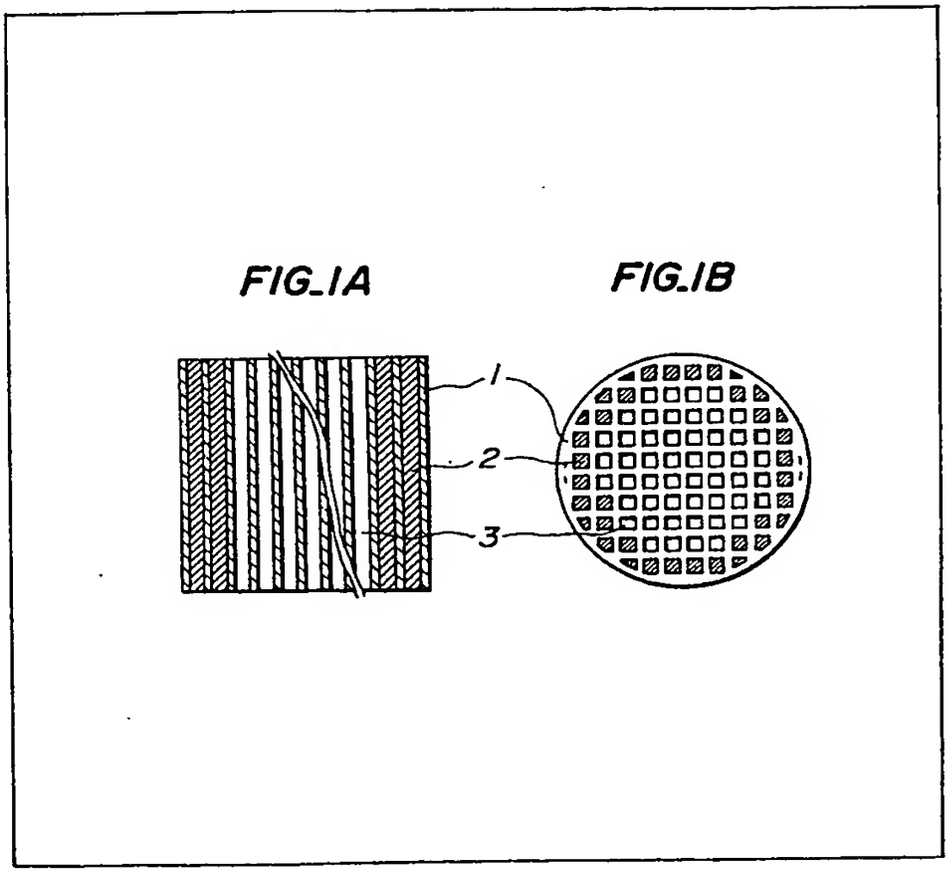

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FIG_1A

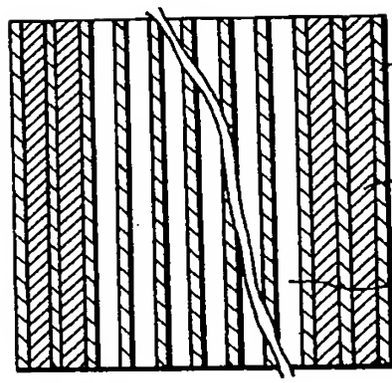


FIG_1B

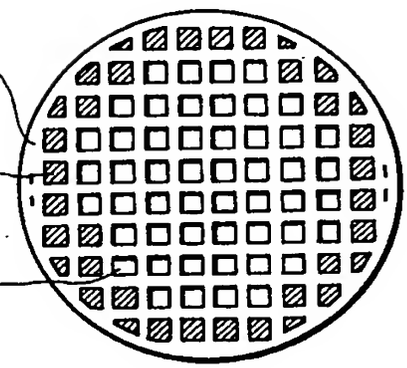


FIG_2A

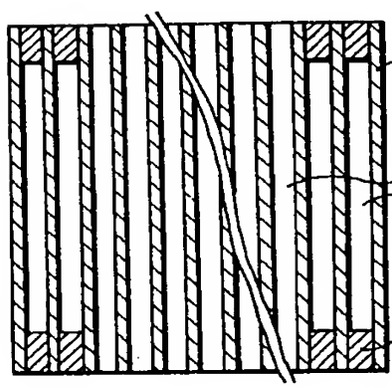
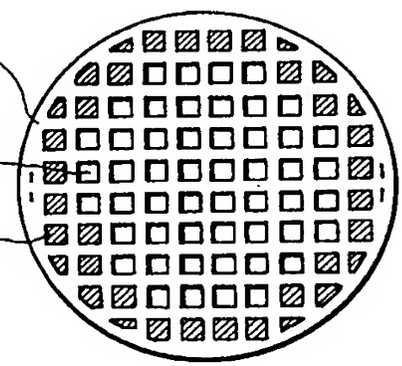


FIG_2B



SPECIFICATION

Ceramic honeycomb body

The present invention relates to a ceramic honeycomb body, to be used for example as a catalyst support for purifying exhaust gases of an internal combustion engine.

In general, ceramic honeycomb bodies have a large surface area per unit volume and have excellent heat resistance and are used for example as catalyst supports for purifying exhaust gases of internal combustion engines. It is desirable, for the purpose of improving the function of such bodies, that partition walls defining the channels of the honeycomb body are thinner and have a larger porosity. However, when the partition walls are made thinner and the porosity is increased, the mechanical strength of the honeycomb body itself is lowered. When a honeycomb body is practically used, it is put in a holder and set in for example an internal combustion engine system, but the body is apt to be chipped, or when the clamping pressure of the holder is increased for preventing vibration, the honeycomb body is apt to be cracked.

For preventing these drawbacks, the following methods have been proposed:

(1) Coating a glaze only on the outer peripheral wall surface of a honeycomb body (Japanese Utility Model Laid Open Application No. 133,860/78);

(2) Coating heat resistant glass ceramic powder only on the outer peripheral wall (Japanese Utility Model Application Publication No. 34,373/78); and

(3) Thickening the outer peripheral wall of a ceramic honeycomb body by an integrally extruding method (Japanese Patent Laid Open Application No. 88,908/74).

However, in the former two methods, wherein only the outer peripheral wall surface of a honeycomb body is coated with a reinforcing material, the strength of the body cannot be satisfactorily improved. In the latter method, strain is caused in the honeycomb body upon firing, and cracks often occur at the peripheral portion, and therefore the strength of the body also cannot be satisfactorily improved.

The present invention provides a ceramic honeycomb body, wherein the channels extending therethrough near the outer peripheral portion of the body are at least partly filled with a reinforcing material.

In order to prevent slippage of a honeycomb body caused by vibration, both ends of the body are generally clamped between two flanges which project inwardly in a holding vessel from the inner surface thereof, when the honeycomb body is held in the holding vessel. In this case, the channels extending inwardly along several millimeters from the outer periphery of the honeycomb body are closed by the flange and do not permit a fluid to flow therethrough. The present inventors noticed this point and therefore utilized it by filling a reinforcing material in the channels at the above described portion to reinforce the portion.

The reinforcing material used is preferably a heat resistant material, for example a ceramic material such as cordierite or mullite or a castable refractory material such as alumina cement. The reinforcement can be carried out with respect to both an unfired honeycomb body and a honeycomb body once fired. However, when a ceramic material is used as the reinforcing material, it is necessary to fire the honeycomb body after the channels extending therethrough are filled with the ceramic material. When a castable refractory material is used as the reinforcing material, if a once fired honeycomb body is used, the desired reinforced honeycomb body can be obtained by merely curing the fired honeycomb body after the channels of the body are filled with the castable refractory material, without again firing.

The invention will be further described, by way of example only, with reference to the accompanying drawings, wherein:

Figures 1A and 1B are diagrammatic sectional and side views respectively of a honeycomb body illustrating the channels extending therethrough filled with a reinforcing material over their entire length; and

Figures 2A and 2B are diagrammatic sectional and side views respectively of a honeycomb structural body illustrating the channels extending therethrough filled with a reinforcing material partly along their length from their open end portions.

In Figures 1 and 2, reference numeral 1 represents the outer peripheral wall of the honeycomb body, numeral 2 represents the reinforcing material filled in the channels of the honeycomb body, and numeral 3 represents a channel or channel portion which is not filled with the reinforcing material. Channels near the outer peripheral portion are at least partly filled with a reinforcing material as described above. It is preferable that the channels are filled with reinforcing material over their entire length as illustrated in Figure 1 in order to improve the compression strength of the honeycomb body. However, when it is intended merely to prevent chipping at the end corner portions of a honeycomb body, local filling of a reinforcing material in the channels from their end surfaces up to a given depth as illustrated in Figure 2 is effective.

The invention will now be further described with reference to the following illustrative Examples.

EXAMPLE 1

As ceramic honeycomb bodies to be reinforced, there were used fired and unfired cordierite

ceramic honeycomb bodies having an outer diameter of 90 mm, a length of 110 mm, a thickness of the partition walls of 0.3 mm, a thickness of the outer peripheral wall of 0.3 mm, and a channel number per square inch of about 300. As reinforcing materials there were used unfired ceramic raw material formulated for producing the cordierite ceramic honeycomb body, and cordierite powder having a grain size of not larger than 100 mesh obtained by grinding the fired ceramic honeycomb body. Each of the powders were mixed together with water and binder in the following mixing ratio to obtain pasty filling materials A and B.

Filling material A:	*Parts by weight*
Cordierite ceramic raw material (unfired)	100
Water	25
Carboxylmethylcellulose	2
Filling material B:	***Parts by weight***
Cordierite powder	100
Water	22
Carboxylmethylcellulose	2

A plastic mask was tightly adhered to the area of the end surfaces of the honeycomb body in which the channels should not be filled with the filling material, and the above described pasty filling material was filled in the channels near the outer periphery of the honeycomb body. Each of the pasty filling materials A and B was filled in the channels up to a depth of 10 mm from the end surface of the channels or filled in the channels over their total length. After the filling, the water in the pasty filling material was removed by drying and the dried honeycomb body was fired at 1,370—1,400°C for 12 hours under an oxidizing condition to obtain the desired ceramic honeycomb body.

The reinforcing effect was estimated in the following manner. The impact strength of the filled portion was indicated by the breaking energy measured by means of a Chalpy Impact Tester. Further, the compression breaking load was measured by using a jig matched to the outer peripheral shape of the honeycomb body by means of a universal testing machine. The obtained results are shown in the following Table 1.

TABLE 1

(average value of five samples)

	Honeycomb body at the filling		Filling Material		
			A	B	Not filled
Impact breaking energy (kg·cm)	Unfired body	total length both end portions	3.4	3.1	1.5
	Fired body	total length both end portions	3.0	3.3	
Compression breaking load (kg)	Unfired body	total length	3,210	3,080	1,660
		both end portions	2,360	2,490	
	Fired body	total length	3,230	3,270	
		both end portions	2,410	2,340	

EXAMPLE 2

A fired ceramic honeycomb body, which was the same as used in Example 1 in respect of the material and the shape thereof, was used as a ceramic honeycomb body to be reinforced. Alumina cement was used as reinforcing material, and 100 parts by weight of alumina cement were mixed with 20 parts by weight of water to prepare a pasty filling material. The filling material was filled in the channels near the outer periphery of the honeycomb body over the entire length of the channels. The honeycomb body filled with the filling material was immersed in water at 20°C over one day to cure the cement, and then the above treated honeycomb body was left to stand for one week in air. Then, the strength of the reinforced honeycomb body was measured in the same manner as described in Example 1. The obtained results are shown in the following Table 2.

TABLE 2

(average value of five samples)

	Filled with alumina cement	Not filled
Impact breaking energy (kg·cm)	5.5	1.5
Compression breaking load (kg)	2,310	1,660

It can be seen from the above described examples that the reinforced ceramic honeycomb bodies according to the present invention obtained by filling the channels over their entire length with a ceramic material having the same formulation as that of a honeycomb body to be reinforced have a compression strength of as high as about twice that of honeycomb bodies whose channels are not filled with a reinforcing material, and further have an impact breaking energy of as high as about twice that of the honeycomb bodies whose channels are not filled with a reinforcing material. (Since the impact breaking energy is measured by putting the steel nose of a Chalpy Impact Tester to the portion filled with a ceramic material, a honeycomb body whose channels are locally filled with the ceramic material has the same impact breaking energy as a honeycomb body whose channels are filled with the ceramic material over their entire length.) Furthermore, the honeycomb body whose channels are filled with alumina cement has an impact breaking energy of as high as about 3.5 times that of the honeycomb body whose channels are not filled with alumina cement, and further has a compression breaking strength of as high as about 1.5 times that of the honeycomb body whose channels are not filled with alumina cement.

Also, as seen from the above described examples, a honeycomb structural body whose channels are filled with a reinforcing material over their entire length is hardly broken even when the pressure for clamping a holder for the honeycomb body is increased. Even the honeycomb structural body whose channels are reinforced only in parts extending from both end surfaces thereof in order to prevent chipping of the edge portions of the body has a strength as high as about 3 times that of a honeycomb body whose channels are not reinforced, and has a high resistance against breakage due to vibration.

CLAIMS

1. A ceramic honeycomb body, wherein the channels extending therethrough near the outer peripheral portion of the body are at least partly filled with a reinforcing material.

2. A ceramic honeycomb body as claimed in claim 1, wherein the channels near the outer peripheral portion of the body are filled with reinforcing material only at the parts extending from both end surfaces of the body in the extending direction of the channels.

3. A ceramic honeycomb body as claimed in claim 1, wherein the channels near the outer peripheral portion of the body are filled with reinforcing material over the entire lengths thereof.

4. A ceramic honeycomb body as claimed in any of claims 1 to 3, wherein the reinforcing material is a ceramic material.

5. A ceramic honeycomb body as claimed in claim 4, wherein the reinforcing material is cordierite or mullite.

6. A ceramic honeycomb body as claimed in any of claims 1 to 3, wherein the reinforcing material is a castable refractory material.

7. A ceramic honeycomb body as claimed in claim 6, wherein the reinforcing material is alumina cement.

8. A ceramic honeycomb body according to claim 1, substantially as herein described with reference to, and as shown in, Figure 1 or Figure 2 of the accompanying drawings.

9. A ceramic honeycomb body according to claim 1, substantially as herein described in any of the foregoing Examples.

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